Early Life Events and Health Outcomes in Late Life in Developing Countries—Evidence from the Mexican Health and Aging Study (MHAS)

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Abstract

In this paper, we investigate the interplay between early life events, childhood and current socioeconomic conditions and health, focusing specifically on type 2 diabetes mellitus (DM) in mid and late-life in Mexico. The analysis uses data from baseline of the Mexican Health and Aging Study (MHAS), a nationally representative, prospective panel study of Mexican born in 1950 or earlier. The central issue we address is to which extent antecedents in childhood before age 10 such as exposure to infectious diseases, the family's social ad economic background and parental education determine disease patterns above age 50 in Mexico, and specifically the onset of type 2 diabetes. Our results show that if a person has experienced serious health problems before age 10 such as tuberculosis, polio etc., she is at higher risk of developing type 2 diabetes after age 50. Moreover, there is a strong inverse relationship between maternal education and diabetes mellitus in late life of the off-springs. A person with a better educated mother has lower odds to have type 2 diabetes after age 50, and this relationship remains after controlling for other childhood and current socioeconomic characteristics.

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1 Introduction

Recent epidemiologic, demographic, and economic history imprints on adult health dynamics in a manner that uniquely characterizes population aging in Mexico and most of Latin America (McCarthy 2004; Palloni et al. 2002). Key features of these macro changes are: *(i)* a

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compressed pace of population aging, rivaling that of Japan in the 1950s[1], even while the rate of increase in the total population of Mexico and much of Latin America continued largely unabated, creating conditions generally favorable to economic development, but unrealized in Mexico; *(ii)* concentration of mortality decline at young ages, possibly implying an older population with higher levels of frailty as cohorts who would have previously succumb to infectious and acute diseases now survive to reproductive ages and beyond, as predicted by life course epidemiology[2] (Kuh et al. 2003); *(iii)*, in contrast to developed countries where population aging typically lags economic development, with its attendant improvements in GDP, wages, and welfare, health, and pension benefits, in Mexico, economic development lags behind the momentum of population aging (Behrman et al. 2003); and, *(iv)*, the persistence of substantial health inequalities in a population with a highly skewed distribution of wealth.

Because the current older population in Mexico was exposed to transitional health regimes, Mexico is an ideal setting in which to explore how structural changes in morbidity and mortality risks affect old-age health. For example, the old population of Mexico consists of men and women who survived a mortality regime with high levels of infectious diseases. In comparison, the increasing number of Mexicans who will celebrate their 60th birthday in the first quarter of this century will have reaped the benefits of an epidemiological regime dominated much less by infectious diseases and substantially more by chronic conditions common in most developed countries (Palloni and Lu 1997). Thus, Mexico's potentially unique old age health dynamics are shaped by the unusual interactions between chronic conditions, which increasingly dominate the current morbidity and mortality patterns, and infectious diseases that are residual to the earlier epidemiological regime. This 'epidemiological polarization' (Frenck and et al. 1990) may yield a higher load of symptoms, physical limitations, and functional disability for the older Mexican population compared to other pre- or post-transitional countries.

In addition, the health dynamics of the elderly cannot be considered in isolation from the large economic disparities which have characterized Mexico in the 20th century and correlate with elevated disease risks, poor sanitation, nutritional deficiencies, widespread environmental hazards, and uneven access to health care. Using data on the physical stature of working class military "recruits" and wealthy passport applicants in Mexico over the period from 1870 to 1950, Lopez-Alonso and Condey (2003), for example, demonstrated that there had been only modest gains in height over the 80 year period they considered. The average Mexican male born in 1940 was only slightly taller than his counterpart born in 1870. More importantly, there were marked social differences in increases in stature with most improvements accruing to wealthy Mexicans. Therefore, without sufficient attention to the life cycle interactions between health and socioeconomic factors, health dynamics in elderly Mexicans are inadequately described.

In this paper we focus specifically on the correlation of early life conditions and type 2 diabetes in mid and late life in Mexico. Our analysis draws on the substantial epidemiologic literature on this relationship. Barker and colleagues have suggested that the dynamic link between impoverished early life circumstances and an increased risk of a number of

[1]Throughout the 1950s, both Japan and Mexico had a rate of increase in the 60+ population of .026. During this same decade, however, the total population in Mexico increased by .029 while Japan's increased by only .012.

[2]This prediction is consistent with notions of life course epidemiology (Ben-Shlomo and Kuh 2002; Kuh et al. 2003) as well as the 'fetal origins' hypothesis of Barker and colleagues, and a large literature linking childhood conditions, including nutrition and SES conditions, with adult health (see, for example, Beebe-Dimmer et al. (2004); Lawlor et al. (2002); Marmot and Wilkinson (2001); Power and Hertzman (1997)).

metabolic syndrome diseases, diabetes and vascular conditions, among them, begins in utero (Barker and Osmond 1986, 1987; Barker 1992, 1994). It is now widely accepted that a uterine environment lacking essential nutrients slows or restricts fetal growth and markedly increases the odds of low birth weight infants (Hales and Barker 1992). At issue today for biomedical researchers is the mechanism by which in utero and early life conditions launch a cascade of metabolic processes alternatively characterized by insulin sensitivity or insulin resistance, which increases the risk of more proximate determinants of type 2 diabetes, notably obesity (Boule et al. 2003; Martorell et al. 2001).

Our goal in this paper is far more modest and part of a growing body of socio-behavioral research concerned with tracing the socioeconomic pathways by which the early life environment affects adult health and mortality (Case et al. 2002; Elo and Preston 1992; Zimmer and House 2003). Based primarily on observational data, this literature also documents the strong correlation between early life conditions and late life health. Among the health outcomes at older ages associated with early life conditions are cognitive function (Jefferis et al. 2002; Richards et al. 2001, 1999) rate of physical growth (Montgomery et al. 1997), onset of menopause (Hardy and Kuh 1999), emotional distress. Many of these early-late life relationships also capture other aspects of life cycle development including the acquisition of schooling and other aspects of human capital (Schultz 2003), exposure to occupational and environmental hazards, accrual of health insurance, pensions, and wealth. Even omitting from consideration inter-generational genetic correlations of birth weight, body mass, innate endowments, and behavioral risks, isolating the effects of childhood circumstances on late life health remains a considerable challenge.

We focus on the link between early life and type-2 diabetes in latter life not only because of the rich epidemiologic and biologic literatures on these interrelationships but also because of the near epidemic prevalence of diabetes among Mexicans and Mexican-Americans. The 2000 National Health Survey in Mexico confirms the increasing prevalence of both obesity and type 2 diabetes. The current prevalence of type 2 diabetes is estimated to be approximately 3.6 million cases, and currently, type 2 diabetes is the third cause of death in Mexico and the primary cause of death in the population 55 to 64 years old (Barquera et al. 2003). Diabetes mellitus imposes a substantial economic burden on individual Mexicans[3] and the country as a whole. For instance, Arredondo and Zuniga (2004) estimate the total cost of diabetes in 2005 to Mexico as $317.6m (in USD), a 26% increase since 2003. These costs include the high direct costs of diagnosis and treatment but also high indirect costs associated with loss of productivity from increasing levels of disability and premature mortality (Barceló et al. 2003; Maty et al. 2004).

Currently, there are two, not mutually exclusive, main hypotheses proposed to explain the onset of the diabetes epidemic in developing countries: *a)* the 'thrifty genotype' hypothesis attributes the current high prevalence of type 2 diabetes in low- and middle-income countries to the expression of 'thrifty genes' that are thought to have improved survival chances at a time the food supply was insufficient and irregular but have become detrimental in the current context of plentiful food and reduced physical work (Adair and Prentice 2004; Neel 1962; Ong and Dunger 2000); *b)* the alternative 'thrifty phenotype' explanation proposes that permanent metabolic and structural changes—in particular changes in glucose-insulin metabolism—caused by fetal and infant undernutrition increase the risk of developing type 2 diabetes and cardiovascular diseases at adult ages (Forsén et al. 2000; Hales and Barker

[3]Under the current health care system in Mexico, individuals must pay out-of-pocket for their own testing supplies.

1992, 2001; Joseph and Kramer 1996; Lucas et al. 1999; Yajnik et al. 2003; Yajnik 2004). From developmental biology it is well known that stimuli or insults occurring during critical periods in early life can have serious life time health consequences. However, the key element in the debate about the origin of diseases is to which extent the underlying mechanisms are genetic or environmental. In the context of this debate, it is suggested that an essential trait of type 2 diabetes is that the disposition of a person to developing diabetes mellitus after age 50 is determined by the interaction of early childhood (even in utero) conditions and late behavioral and social characteristics (e.g., diet, physical activity, obesity, etc.). That is, the stronger is the mismatch between early childhood conditions such as nutritional deprivation, and later nutritional affluence, the higher is the probability that a person develops diabetes mellitus as an adult.

The central issue we address in this paper is to which extent antecedents in childhood such as exposure to infectious diseases, the family's social and economic background, and parental education determine decease patterns above age 50 in Mexico, and specifically the onset of diabetes mellitus. We also investigate whether the early childhood effects on adult health can be compensated by advances in the own social position in adulthood, or alternatively, is a mismatch between childhood conditions and socioeconomic position in adulthood associated with a higher burden of chronic diseases and in particular, with the development of diabetes mellitus.

The remainder of this paper is organized as following. In the next section, we describe the Mexican Health and Aging Survey (MHAS) as a unique source to study the determinants of adult and old age health dynamics in Mexico, and we shortly describe the methods of analysis. In Section 3 we present the results based on a logistic regression models, and the last section summarizes and discusses our findings.

2 Data and Methods

2.1 The Mexican Health and Aging Study (MHAS)

The proposed research is based on the newly released Mexican Health and Aging Study (MHAS).[4] This panel study provides a unique opportunity to address a broad research agenda on the effects of individual behaviors, migration history, community characteristics, socioeconomic status and transfers on multiple health outcomes of elderly Mexicans.

The Mexican Health and Aging Study (MHAS)/Encuesta Nacional Sobre Salud y Envejecimiento en Mexico (ENSEM) is a prospective panel study, modeled after the Health and Retirement Study (HRS), which served as a template for MHAS. The general goal for initiating the study was to reconcile conflicting understandings of the health (Palloni and Morenoff 2002) and transfer behaviors of first-generation Mexican migrants relative to second and third generation Mexican-Americans. The overall goal of MHAS is to locate descriptions of migrant health and transfers from the HRS in the context of Mexico, a population characterized by burdens of both acute and chronic disease, substantial inequalities in health and wealth, virtually no capital markets, and dominance of the extended family as the institution providing social, human and financial capital. To assess the extent to which Mexican Americans import their family transfer culture or adapt it through assimilation, it was important

[4]Detailed information about the Mexican Health and Aging Study (MHAS) can be found at http://www.ssc.upenn.edu/mhas/.

that MHAS largely replicates the design, coverage, and content of the HRS.

At its baseline in 2001, MHAS was representative of the 13 million Mexicans born prior to 1951. Respondents were selected in conjunction with the 4th Quarter 2000 National Employment Study/Encuesta Nacional de Empleo (ENE), a nationally representative survey conducted by the Instituto Nacional de Estadistica, Geografia, e Informatica (INEGI), the counterpart of the U.S. Census. The ENE provides coverage of both urban and rural residents in all 32 states of Mexico. The entire MHAS sample was drawn from the 64,475 ENE households of which about 40.5% contained one or more persons eligible for MHAS. Interviews averaging 82 minutes in length were conducted with 15,186 eligibles and their spouse/partners for a 90.1% response rate. Households in the 6 Mexican states accounting for 40% of all migrants to the U.S. were oversampled at a rate slightly less than 2:1. All interviews were conducted in-person by full-time INEGI interviewers trained by MHAS Co-PIs and INEGI supervisors in the unique aspects of MHAS, e.g., securing appropriate contact information for follow-up, administering cognitive performance tests, and using unfolding brackets to reduce measurement error in reports of amounts (e.g., hours of time help and pesos earned or transferred). Field supervisors administered to a 20% random subsample a series of anthropometric measures, including height, weight, knee height, hip and waist circumference, and timed one-leg stands. The MHAS questions on use of health care services, pensions, sources of income and assets were customized to the infrastructure of the country, while the questions on various other social and economic attributes are identical to those in HRS. MHAS includes several performance tests, including learning and recall, also are known as immediate and delayed word recall.

The second wave of MHAS including next-of-kin interviews for diseased respondents was completed in the fall 2003. As in HRS, spouses or partners who separate are independently followed. New spouse/partners (and children from an earlier marriage or union) are also included in the second wave of MHAS in 2003. The attrition rate between the two waves is 7.31% (1,110 persons of the initial sample are lost). In the two-year period between the two waves of the survey, 541 (3.56%) individuals died of whom 277 (51.20%) are men and 264 (48.80%) are women.

In the present analyses, we restrict our sample to all individuals who are 50 to 105 years old at baseline in 2001. In addition, we include only respondents with a direct interview (that is, the questionnaire is answered by the respondent herself). As our outcome variable of interest is whether the respondent was ever diagnosed with diabetes by a doctor or medical personnel, we additionally restrict the sample to individuals who have ever seen a doctor or medical personnel.[5]

[5] This last constraint of the dataset is based on the strong assumption that there is no significant difference between those who have ever used medical care, and those who have never seen medical personnel or a doctor in their life. However, the later group may represent in fact a very selected group of individuals and may differ in term of observed and unobserved characteristics substantially from the respondents included in our analyses. There are many ways how these people may differ from the rest of the population: for example, individuals who have diabetes and related health complications are probably more likely to seek medical help and receive medical treatment. Thus, the out-sampled individuals may represent in fact a selected group of healthier individuals. Other possibility is that these people are either very poor and cannot afford medical services, or they live in isolated areas with very restricted access to medical care services. Another possible difference may exist in the knowledge about diseases and diseases patterns so that individuals who have seen a doctor have a better understanding about interpretation of disease symptoms.

Of all respondents 50 years old or older, 2.43% (303 individuals) have never seen a doctor in their life. Our summary statistics shows that the mean age of the respondents included in our analyses is 62.07 years (sd. 9.4), while those who have never required any medical help have a mean age of 62.14 (s.d. 9.6) years.

Table 1: Summary statistics for the MHAS sample age 50–105, included in the present analyses

Variable	Men	Women	Total
N	5,536 (45.46 %)	6,642 (54.54%)	12,178
Age (mean)	62.29 (9.48)	61.89 (9.32)	62.07 (9.4)
Years of education (mean)	5.06 (4.83)	4.10 (3.98)	4.53 (4.42)
Having type II diabetes	790 (14.27%)	1,171 (17.63%)	1,961 (16.10%)
Self-reported BMI (mean)	26.85 (4.84)	27.65 (5.28)	27.24 (5.09)
Obese	920 (16.62%)	1,269 (19.11%)	2,189 (17.98%)
Overweight	2,025 (36.58%)	1,760 (26.50%)	3,785 (31.08%)

Notes: Standard deviation in parentheses.

Table 1 shows summary statistics of the sample included in these analyses. Our sample includes 12,178 respondents of whom 5,536 (45.46%) are men and 6,642 (54.54%) are women. The mean age of female respondents is 61.89 years, while that of male respondents is 62.29 years. On average, men have 5.05 years of education, while women have about one year less education (4.10 years). However, one should note that the educational distribution of Mexico is skewed and 25% of men have one or less years of education, while a quarter of the women have no any formal education (zero years of education). Ten per cent of men have 12 or more years of education, while only five per cent of women fall in this category. Table 1 clearly illustrates the high prevalence of diabetes' in Mexico—14.27% of men and 17.63% of women in our sample have been told by a doctor or medical personnel that they have diabetes or high blood sugar level.[6] These results based on self-reports of diabetes

The majority of these people are men (60.4%). However, those who have never seen a doctor in their life are less educated and have on average 1.5 years less education than the sample included in our analyses.

In order to investigate whether our restriction of the sample imposes any problems for the subsequent analyses, we performed tests for the robustness of our results. We assumed two extreme scenarios: a) First, we assumed that all those who have never seen a doctor in their life do not have diabetes; b) second, we assumed exactly the opposite, i.e. all individuals in this group have diabetes. We estimated our models for the two scenarios and the results (not reported here) remained stable and the patterns of the coefficients did not change substantially and all reported results still hold. Thus, we think that this restriction of our sample does not infringe our conclusions.

[6]We don't include in our analyses people who don't answer this question positively, but on the basis of symptom listings may fall in this category.

are consistent with other estimates such as from the ENSA. Obesity, one of the strongest predictors of diabetes, is also highly prevalent in our sample. 16.62% of men and 19.11% of women are with a body mass index (BMI) above 30. In contrast to obesity, about 10% more men are overweight than women.[7]

2.2 Methods

We assume that health status of an individual i evolves over the life cycle as a function of age, education, other socioeconomic characteristics, potentially acquired at different stages in life such as childhood or adulthood. Our analyses are based on a standard logistic model, in which the dependent variable is the logit of the probability of having a certain health outcome above age 50 (e.g., having diabetes mellitus). The model is defined as follows:

$$\log[\frac{p_i}{1-p_i}] = \beta_0 + \beta_1 x_{i1} + \beta_{i2} x_{i2} + \dots \beta_k x_{ik}, \tag{1}$$

where $i = 1, \dots, n$ is the number of individuals included in the analyses, and k corresponds to a set of explanatory variables included in the analyses.

As noted already in the above section, Mexico is characterized by a skewed distribution of the population by educational achievement, and substantial differences in completed education are observed among generations. In order to account for these cohort differences and 'correct' for the compositional changes over time, we transform the respondent's 'years of education' into $z-$scores so that it has a mean 0 and variance 1 within each cohort. The value of the $z-$scores represents the relative position of the individual with respect of education in his or her cohort.

3 Results—Childhood Predictors of Type 2 Diabetes in Mexico

Table 2 shows the odds ratios for reporting to have type 2 diabetes after age 50 in the MHAS sample. We estimate three different models in which we include various childhood characteristics and current socio-demographic characteristics of the respondents. Model 1 is our baseline model that controls for common socioeconomic characteristics of the respondents. Model 2 includes in addition indicators for the final level of education of both parents as reported by the respondents, and Model 3 controls in addition to parental education for other socioeconomic childhood conditions such as housing, economic situation, etc.

The results show that the odds ratios of having diabetes mellitus associated with basic socio-demographic characteristics such as sex, age, years of education, marital status are remarkably stable independent of the model specification. For example, the basic model (Model 1) shows that females have a 22 per cent higher odds of having diabetes after age 50 than men included in the MHAS sample, and this difference increases to about 34 per cent in Model 3. Higher education is associated with lower odds ratios of diabetes after age 50. A one standard deviation increase in the z-scores of education decreases the odds for diabetes by 13 per cent in Model 1, and by 11 per cent in Model 3. As expected, obesity is a strong and significant predictor of type 2 diabetes. Individuals with a BMI above 30 have about

[7] Body mass index (BMI) is calculated on the basis of self-reported weight and height. These indicators are available for 9,131 individuals.

Table 2: Odds ratios for the probability of self-reporting diabetes after age 50 derived from logistic regression models: MHAS

Dependent variable Self-reported diabetes after age 50	Model 1	Model 2	Model 3
Socioeconomic variables			
Female	1.223**	1.239**	1.338**
	(0.073)	(0.080)	(0.097)
Age	1.283**	1.247**	1.209**
	(0.055)	(0.057)	(0.063)
Age squared	0.998**	0.998**	0.999**
	(0.000)	(0.000)	(0.000)
z-scores of years of education	0.868**	0.889**	0.893*
	(0.026)	(0.034)	(0.040)
Has serious health problem before age 10	1.177*	1.164^{+}	1.170^{+}
	(0.088)	(0.095)	(0.107)
Living in community 100,000+ people	1.341**	1.367**	1.391**
	(0.094)	(0.104)	(0.118)
Married or in consensual union	1.253**	1.238**	1.246**
	(0.085)	(0.091)	(0.102)
Obese (BMI > 30)	1.221*	1.197*	1.221*
	(0.095)	(0.101)	(0.113)
Overweight (25<BMI<30)	1.097	1.134^{+}	1.130
	(0.076)	(0.084)	(0.094)
Underweight (BMI < 18)	0.769	0.829	0.839
	(0.194)	(0.217)	(0.261)
Parental education			
Mother with some elementary education		0.969	1.019
		(0.080)	(0.095)
Mother with completed elementary education		0.681**	0.755^{+}
		(0.097)	(0.120)
Mother with more than elementary education		0.520**	0.609*
		(0.112)	(0.145)
Father with some elementary education		1.024	1.014
		(0.084)	(0.093)
Father with completed elementary education		1.186	1.191
		(0.158)	(0.176)
Father with more than elementary education		1.136	1.261
		(0.181)	(0.225)
Childhood economic and housing characteristics before age 10			
Had inside toilet			0.800*
			(0.072)
Slept in same room used for cooking			0.982
			(0.093)
Went to bed generally hungry			1.004
			(0.086)
Respondent or sib dropped out of school to help parents			1.117
			(0.085)
Wore shoes regularly			1.301**
			(0.126)
Family received help because economic reasons			0.868
			(0.110)

*Notes:*Standard errors in parentheses. *p-values:* $^{+}$ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$. The standards errors are adjusted for clustering within households by using the Huber-White estimator of variance. Model 3 includes also binary indicators for current region of residence that are not reported in the table.

22 % higher odds to have diabetes after age 50. Being overweight is also associated with a higher probability to develop diabetes in late life, however, with the exception of Model 2 the results are not statistically significant. Interestingly enough, being married or in a consensual union are positively associated with diabetes in the MHAS sample and the odds of married individuals to have diabetes after age 50 increase by 23 to 25 %. Another result that is consistent with the existing research on diabetes show that men and women who live in more urbanized communities (i.e., communities with more than 100,000 residents) have 34 to 39 % higher odds to have diabetes. This pattern is very often attributed to bad diet, less physical activities, and other adverse health behaviors.

As we are interested in the effect of early life events on the probability of having diabetes after age 50, we include in all our model specifications an indicator for having serious health problems before age 10. This indicator is composed as a binary variable that shows whether a person had either tuberculosis, rheumatic or typhoid fever, polio, a serious blow in the head with faint, or any other serious health problem as a child before age 10. The effect of this variable is remarkably stable and the results show that having a serious health problem in childhood is associated with 17 per cent (16 % in Model 2) higher odds of developing diabetes after age 50. This association does not change and remains statistically significant even when we control for other childhood characteristics in the models.

Model 2 in Table 2 presents an extension of our basic model and includes parents' characteristics. In particular, we include indicators for mother's and father's education as reported by the respondents.[8] The results show that while father's education of the respondent is not a significant predictor of diabetes in late life, the pattern for mother's education is strikingly different. If the respondent's mother was better educated, that is the mother had completed elementary or more than elementary education, this decreases the respondent's odds to develop diabetes in late life significantly. The gradient is clearly observed: for example, individuals whose mothers had more than elementary schooling have 48 per cent lower odds for having diabetes than individuals whose mothers did not have any education. If the mother had only completed elementary school, the effect is lower and the odds of having diabetes are 32 per cent compared to the reference group. Compared to individuals whose parents did not have any education, the odds for having diabetes after age 50 are reduced by 41 per cent (.52*1.136=.59 odds ratio) for respondents whose both parents had more than elementary level of schooling.

The inverse association between level of mother's education and diabetes in late life is striking in the sense that it remains significant even when controlling for current usually very strong predictors of type 2 diabetes such as obesity, sex, age, respondent's own education. The pathway through which mother's education affects diabetes risk is not unambiguous and raises several potential explanations. On one side, the association suggests that type 2 diabetes may indeed originate under conditions of poor pre- or post-natal nutritional environment, so that more educated women are better providers of nutritional environment to their children. On the other side, the effect may operate through the accumulation of health capital transferred from mother to child: that is, higher mother's education has a greater beneficial impact on children's health through the transfer of increased knowledge about health care and health behavior that are detrimental for health outcomes also in late

[8]Parental education is grouped into three educational categories and is obtained for both parents separately: parents with no formal education have zero years of education. Parents with elementary education have one to five years of education. Completed elementary education corresponds to exactly 6 years of education, and parents with more than elementary education have 7 or more years of education.

life. A third possible explanation of the effect of mother's education is that this variable may better capture socioeconomic differences in childhood than father's education.

Based on our data, we are only able to test whether the effect of mother's education can be explained by differences in the socioeconomic environment during childhood. Model 3 in Table 2 includes in addition to parents' education indicators for the socioeconomic conditions during respondent's childhood such as housing conditions, economic situation of the family, etc. In this model, we include also dummy variables for respondent's birth region (not reported in the table), which control for the regional diversity observed in the socioeconomic structure in Mexico. Model 3 shows that controlling for socioeconomic conditions during childhood reduces the effect of mother's education, but the general pattern observed in the previous model does not change. If the mother had completed elementary education, the odds of the respondents to develop diabetes after age 50 are reduced by 24 per cent, while for individuals whose mothers had more than elementary education the odds are reduced by 39 per cent compared to men and women with parents without education.

Model 3 shows that from all measures of socioeconomic childhood conditions only availability of toilet inside the house and wearing regularly shoes are associated with lower risks of diabetes after age 50. While we are not able to provide an obvious explanation for the positive association of wearing regularly shoes in childhood with type diabetes after age 50, we think that the availability of a toilet inside the house reflects important differences in the housing conditions during childhood associated with exposure to communicable diseases and hygiene.

An existing hypothesis is that a divergence between poor childhood conditions and accumulation of wealth and improvement in socioeconomic status late in life is associated with the development of chronic diseases such as type 2 diabetes. In order to test this hypothesis, we estimated two additional models with interactions between the current net wealth of the respondents and selected childhood characteristics such as availability of toilet inside the house and whether the person or siblings have dropped out of school before age 10 to help parents. In our opinion, these two childhood variables describe well the variation in childhood conditions in Mexico.

The models include an indicator for the current total net wealth of the respondent. This indicator is constructed on the basis of the gross value of all assets and debts the respondents report.[9] For individuals who are more in debts than possessing assets, the net wealth variable can take negative values. For this reason, we rescale the variable so that we add the maximum debts to the wealth of each respondent, and then take the logarithm of the rescaled variable. In addition, when interacting the transformed wealth variable with childhood indicators, we substract the mean of the variable so that the coefficients give the main effect of a childhood characteristic for a person with average log wealth, while the interaction term reports the variation in this effect with increase of the log wealth. The models with interaction effects are summarized in Table 3.

The results show that the effects of the socio-demographic variables do not change magnitude and signs and remain significant also in these two additional models with interaction effects. Moreover, the previously estimated negative effect of mother's level of education on the risk of having diabetes in late life also does not change significantly although it is slightly reduced in the first model in Table 3. Model 1 in Table 3 shows that having a toilet inside the house as a child reduces the odds for having diabetes in late life for a person with a

[9]An exact description of the methodology how the total net wealth was calculated can be found in Wong et al. (2003).

Table 3: Odds ratios for the probability of self-reporting diabetes after age 50 derived from logistic regression models with interaction terms: MHAS

Dependent Variable Self-reported diabetes after age 50	Model 1	Model 2
Socioeconomic variables		
Female	1.327**	1.333**
	(0.094)	(0.095)
Age	1.210**	1.222**
	(0.062)	(0.063)
Age squared	0.999**	0.999**
	(0.000)	(0.000)
z-scores of years	0.902*	0.891**
of education	(0.040)	(0.040)
Has serious health		1.169^{+}
problem before age 10		(0.105)
Living in community	1.363**	1.345**
100,000+ people	(0.114)	(0.113)
Married or in consensual	1.247**	1.243**
union	(0.102)	(0.101)
Obese	1.228*	1.237*
(BMI > 30)	(0.113)	(0.115)
Overweight	1.139	1.144
(25<BMI<30)	(0.094)	(0.095)
Underweight	0.773	0.791
(BMI < 18)	(0.238)	(0.245)
Parental education		
Mother with some	1.012	1.006
elementary education	(0.094)	(0.093)
Mother with completed	0.760^{+}	0.759^{+}
elementary education	(0.121)	(0.121)
Mother with more than	0.621*	0.601*
elementary education	(0.150)	(0.145)
Father with some	1.022	1.031
elementary education	(0.093)	(0.095)
Father with completed	1.187	1.171
elementary education	(0.175)	(0.173)
Father with more than	1.263	1.224
elementary education	(0.226)	(0.219)
Childhood economic and housing characteristics before age 10		
Had inside toilet	0.838*	
	(0.073)	
Current log net wealth	1.193	0.892
	(0.138)	(0.100)
Interaction toilet with	0.661*	
current log net wealth	(0.120)	
Dropped out of school		1.113
		(0.080)
Interaction dropped out of school with		1.384^{+}
current log net wealth		(0.244)

Notes: Standard errors in parentheses. *p-values:* $^{+}$ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$. The standards errors are adjusted for clustering within households by using the Huber-White estimator of variance. Model 2 includes also binary indicators for current region of residence that are not reported in the table.

mean log wealth by about 16 per cent. There is no significant effect of current log wealth for people who fall in the opposite category (i.e., there was no toilet inside the house where they lived before age 10). The interaction term in the model reveals that a one unit increase in the log net wealth decreases the odds in having diabetes after age 50 by additional 34 per cent conditional on having a toilet in the house during childhood. Hence, the overall effect of one unit increase in log net wealth (one unit increase corresponds to 2.7 fold increase in net wealth) for a person with toilet in childhood equals $1.193 * .661 = .78$. In summary, Model 1 suggests that respondents who enjoyed better housing conditions as a child as measured by the availability of toilet inside the house may in fact be a subject of a lower risk of developing diabetes.

Model 2 in Table 3 shows that there is no statistically significant effect of dropping out of school before age 10 due to economic difficulties of the family if a person has currently an average log wealth. The interaction term however reveals that conditional on early drop out of school before age 10, a one unit increase in the current log wealth of the individual is associated with a 38 per cent increase in the odds of having type 2 diabetes in late life. The direction of this association suggests that there might be indeed an interaction between bad early childhood circumstances and late life disease outcomes such as diabetes. Of course, one should be very careful when interpreting these results as we don't know which aspects of early childhood conditions are captured by the variables 'toilet inside the house' and 'dropping out of school to help parents'.

4 Conclusions

In this paper, we investigate whether early childhood conditions can predict the onset of chronic diseases such as type 2 diabetes after age 50 in the context of developing countries. This question is of a particular relevance as the elderly and old population in developing countries and in particular in Mexico has been exposed on one side to different epidemiologic regimes during their life course such as exposure to infectious deceases in childhood and increasing chronic conditions in late life. On the other side, the elderly Mexican population has experienced different socioeconomic regimes characterized by highly skewed distribution of wealth and substantial health inequalities throughout the 20th century. Thus, Mexico represents an ideal setting to investigate the interplay between early life events, socioeconomic conditions throughout the life course and health outcomes in late life.

Our specific focus in this paper is on type 2 diabetes, a disease that is highly prevalent in Mexico and is associated with high health and economic burden. Moreover, a large body of epidemiologic and medical research suggests that the origin of type 2 diabetes is determined by the interplay of genetic and environmental mechanisms that start operating in early childhood or even before birth in utero. Thus, diabetes mellitus represents an interesting case to investigate the dynamic link between early life circumstances and an increased risk of chronic conditions in late life.

Our results suggest a strong and persistent association between early childhood conditions and having diabetes after age 50 in Mexico. For example, individuals who have experienced a serious health problem during childhood such as tuberculosis, typhoid fever, polio, have higher odds for having type 2 diabetes after age 50. One of the most striking results is the strong association between the mother's education and the probability to have diabetes after age 50. Respondents with better educated mothers, that is mothers with completed elementary or more than elementary education, have significantly lower odds to have diabetes after age 50. This inverse relationship between level of mother's education and diabetes in late life is striking in the sense that it remains stable even after controlling for current strong predictors of type 2 diabetes such as sex, age, obesity and own education.

Even though we find this strong association between early childhood conditions and diabetes mellitus in late life the interpretation of these results is not straightforward and several potential explanations can be proposed. On one side, the observed association suggests that type 2 diabetes may originate under conditions of poor pre- or post-natal nutritional environment, so that better educated mothers are better providers of nutritional environment to their children either before birth (in utero) or afterwards. On the other side, better educated mother may transfer to their children better knowledge about health behavior and health care that are detrimental for health outcomes in late life. On the basis of our data, however, we are not able to disentangle the exact mechanism linking diabetes in late life to early childhood conditions.

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